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THE PHYLA, CLASSES, AND ORDERS OF PLANTS

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The Plant World is here regarded as readily divisible into fourteen phyla, thirty-three classes, and many more orders. Elsewhere* I have set forth somewhat fully the principles underlying the taxonomy of plants, and have given in considerable detail such a resulting classification. In this paper there appears for the first time the key to the phyla of plants which I have used in some of my University classes in systematic botany. The synoptical view of the phyla, classes, and orders which follows this key will, I hope, prove helpful to teachers and students, as well as others who are interested in the broader aspects of plant classification.

KEY TO THE PHYLA OF PLANTS

- A. Cells typically with poorly developed nuclei and chromatophores; reproducing by fission and spores; mostly blue-green, brown-green or fuliginous (or colorless), never chlorophyll green.
 - I. Unicellular to filamentous plants. Phylum 1. *Myxophyceae*.
- B. Cells typically with well-developed nuclei and chromatophores; reproducing by fission and spores, and mostly by gametes also; chlorophyll-green, sometimes hidden by other coloring matter (or colorless).
 - I. Plants of but one obvious generation, typically aquatic.
 - a. The fertilized egg developing into a zygote only.
 - 1. Unicellular, to filamentous many-celled plants (rarely a plate of cells): isogamic to heterogamic. Phylum 2. *Protophyceae*.
 - 2. Filamentous many-celled plants, mostly breaking up early into single cells; isogamic. Phylum 3. *Zygophyceae*.
 - 3. Tubular filamentous (or saccate) coenocytic plants, usually attached basally by rhizoids; isogamic to heterogamic. Phylum 4. *Siphonophyceae*.
 - 4. Cellular filamentous to massive plants, attached basally by rhizoids (or roots): isogamic to heterogamic; the green color hidden by a brownish pigment. Phylum 5. *Phaeophyceae*.

**A Synopsis of Plant Phyla*. University of Nebraska Studies. Vol. VII. October, 1907.
The Phyletic Idea in Taxonomy. Science, Vol. XXIX. January, 1909.
Outlines of Plant Phyla. University of Nebraska, Department of Botany. September, 1909.

- b. The fertilized egg developing into a spore-fruit.
 - 1. Cellular filamentous to massive holophytic plants, attached basally by rhizoids (or roots); heterogamic: the green color mostly hidden by a red or purple pigment.
Phylum 6. *Carpophyceae*.
 - 2. Cellular filamentous hysterozytic plants, often much degenerated, without chlorophyll; heterogamic.
Phylum 7. *Carpomycetaceae*.
- II. Plants of two obvious, alternating generations, typically terrestrial.
 - a. Gametophyte generation larger, and longer-lived than the dependent sporophyte generation.
 - 1. Gametophytes from prostrate and thalroid to erect leafy shoots; sporophytes from globose to cylindrical or stalked, neither expanded nor rooted.
Phylum 8. *Bryophyta*.
 - b. Gametophyte generation smaller and shorter-lived than the independent sporophyte generation.
 - 1. Both generations more or less holophytic and independent.
 - (a) Gametophytes typically flat and thalroid, normally attached by rhizoids, mostly monoecious; sporophytes consisting of large-leaved, solid stems, which are rooted below.
Phylum 9. *Pteridophyta*.
 - (b) Gametophytes typically flat and thalroid, normally attached by rhizoids, mostly monoecious: sporophytes consisting of mostly solid, cylindrical, jointed and fluted stems, bearing small, whorled leaves at the nodes, and rooted below.
Phylum 10. *Calamophyta*.
 - (c) Gametophytes, typically tuberous or globose, with few rhizoids or none, often dioecious; sporophytes consisting of solid, cylindrical, continuous (not jointed) and not fluted stems, bearing small spirally arranged (or opposite) leaves, and rooted below.
Phylum 11. *Lepidophyta*.
 - 2. Gametophytes hysterozytic, dependent upon and nourished by the sporophyte.
 - (a) Sporophylls open, ovules and seeds naked (gymnospermous).
 - (1) Gametophytes dioecious: sperms ciliated and motile; sporophytes producing microspores and megaspores in spiral or whorled sporophylls, or these aggregated into cones.
Phylum 12. *Cycadophyta*.
 - (2) Gametophytes dioecious: sperms not ciliated, not motile; sporophytes with sporophylls in cones.
Phylum 13. *Strobilophyta*.
 - (b) Sporophylls closed, ovules and seeds covered (angiospermous).

- (1) Gametophytes dioecious sperms not ciliated, not motile; sporophytes with sporophylls in flowers. Phylum 14. *Anthophyta*.

SYSTEMATIC ARRANGEMENT

Phylum I. MYXOPHYCEAE

The Slime Algae

Usually blue-green, poorly developed cells, or filaments.

- Class 1. ARCHIPLASTIDEAE. (Cyanophyceae) Without nuclear membrane. (Species about 2000.)

Order Coccogonales. Unicellular.

Order Hormogonales. Filamentous.

- Class 2. HOLOPLASTIDEAE. With nuclear membrane. (Species about 20.)

Order Glaucocystales. Dividing in one plane.

Phylum II. PROTOPHYCEAE.

The Simple Algae

Normally chlorophyll-green, with well developed single cells, or filaments.

- Class 3. PROTOCOCCOIDEAE. Green Slimes. Unicellular. (Species about 450.)

Order Palmellales. Cells not in colonies.

Order Coenobiales. Cells in colonies.

- Class 4. CONFERVOIDEAE. Filamentous Algae. Filamentous, or a plane. (Species about 640.)

Order Microsporales. Unbranched.

Order Schizogoniales. Unbranched.

Order Ulvales. Plant a plane or tube.

Order Chaetophorales. Usually branched. Zoospores and ciliated gametes.

Order Coleochaetales. Branched, fusing into discs.

Phylum III. ZYGOPHYCEAE

The Conjugate Algae

Chlorophyll-green, sluggish filaments, often fragmenting into single cells.

- Class 5. CONJUGATAE. Typically filamentous, green plants, with

cellulose walls. (Species about 1300.)

Order Zygnematales. Pond Scums. Filamentous.

Order Desmidiaceae. The Desmids. Filaments usually early fragmenting into single cells.

Class 6. BACILLARIOIDEAE. The Diatoms. Brownish-green plants, with silicified walls. (Species about 5700.)

Order Eupodiscales. The Round Diatoms. Filaments commonly cylindrical, usually fragmented into single cells.

Order Naviculales. The Long Diatoms. Filaments flattened, usually fragmented into single cells.

Phylum IV. SIPHONOPHYCEAE

The Tube Algae

Normally chlorophyll-green filaments composed of one or more coenocytes.

Class 7. VAUCHERIOIDEAE. The Vaucheriid Plants. Filamentous, septate or tubular. (Species about 800.)

Order Cladophorales. The Cladophoras. Septate, the segments coenocytic.

Order Siphonales. Green Felts. Tubular, irregularly branched, chlorophyllose.

Order Siphonophytales. (Phycomycetae) Filaments tubular, irregularly branched, chlorophyll-less.

Class 8. BRYOPSIDOIDEAE. The Bryopsidoid Plants. Globular to stipitate or dendroid, septate or continuous. (Species about 300.)

Order Valoniales. Globular coenocytes to compound septate plants.

Order Dasycladales. Regularly branched, non-septate, marine plants.

Phylum V. PHAEOPHYCEAE

The Brown Algae

Brown-green filamentous to large, massive plants, marine.

Class 9. PHAEOSPORALES. The Kelps. Reproductive organs external, isogamic to heterogamic. (Species about 550.)

Order Ectocarpales. Zoospores and isogametes similar and motile.

- Order Tilopteridales. Zoospores and heterogametes dissimilar, eggs non-motile.
- Order Cutleriales. Zoospores and heterogametes dissimilar and motile.
- Class 10. DICTYOTINEAE. Reproductive organs external, heterogamic. (Species about 130.)
- Order Dictyotales. Plants erect, flat, leaf-like, zoospores and gametes non-ciliated.
- Class 11. CYCLOSPORAEAE. The Rockweeds. Reproductive organs in sunken conceptacles, heterogamic. (Species about 350.)
- Order Fucales. Usually flattish, branched.

Phylum VI. CARPOPHYCEAE

The Higher Algae

- Typically red to purple filamentous to massive plants; mostly marine.
- Class 12. BANGIOIDEAE. Antherids and oogones developed from ordinary cells of plant body; propagation by monospores. Red or purple plants. (Species about 50, doubtfully belonging here.)
- Order Bangiales. One chromatophore in each cell.
- Order Rhodochaetales. Several to many chromatophores in each cell.
- Class 13. Florideae. The Red Seaweeds. Antherids and oogones specially developed; propagation by tetraspores. Red or purple plants. (Species about 3000.)
- Order Nemalionales. Mostly filamentous plants. Sporophores produced directly from fertilized egg.
- Order Gigartinales. Parenchymatous plants; sporophores produced by nearby auxiliary cells branching in the surrounding tissues.
- Order Rhodymeniales. Filiform, cylindrical, to foliaceous plants; sporophores produced by nearby auxiliary cells growing outward in plant body.
- Order Cryptonemiales. Filiform, branched, often complanate; sporophores produced by remote auxiliary cells.
- Class 14. CHAROIDEAE. The Stoneworts. Antherids and oogones

specially developed; no tetraspores. Green plants.
(Species about 160.)

Order Charales. Erect, with whorled branches.

Phylum VII. CARPOMYCETAE

The Higher Fungi

Terrestrial, chlorophyll-less, filamentous, parasites and saprophytes, producing spore-fruits.

Class 15. ASCOSPOREAE. The Sac Fungi. Spore-fruits containing one or more asci with ascospores. (Species about 29,000.)

Order Laboulbeniales. The Beetle Fungi. Erect, minute, few celled, bearing simple ascigerous fruits.

Order Perisporiales. Primitive Sac Fungi. Filamentous, with simple, mostly spherical spore-fruits.

Order Pyrenomycetales. Black Fungi. Filamentous, with mostly compound closed spore-fruits.

Order Pyrenolichenes. The Lower Lichens. Lichen-forming fungi, allied to the preceding families.

Order Hysteriales. The Slit Fungi. True fungi; saprophytic; apothecia opening by a slit.

Order Graphidales. Black Lichens. Lichen-forming fungi, allied to the preceding families.

Order Phacidiales. The Little Cup Fungi. True Fungi, spore-fruits open (apothecia).

Order Caliciales. True fungi, and lichen-forming fungi; apothecia spheroidal, pulverulent.

Order Pezizales. Cup Fungi. True fungi; apothecia at length cup-shaped, fleshy or leathery.

Order Discolichenes. The Higher Lichens. Lichen-forming fungi allied to the preceding families.

Order Helvellales. The Helvellas. True fungi; apothecia open from the first, fleshy or gelatinous.

Order Aspergillales. The Little Tubers. True fungi; spore-fruits minute, mostly not subterranean. (Related to Perisporiales.)

Order Tuberales. The Tubers. True fungi; spore-fruits large, tuberous, subterranean, fleshy, internally ascigerous.

- Order Exoascales. Pocket Fungi. True fungi; apothecia much reduced and simplified.
- Order Hemiascales. Reduced Sac Fungi. True fungi; no apothecia, asci single, scattered.
- Class 16. TELIOSPOREAE. Brand Fungi. Parasitic, much reduced plants producing erumpent sori (but no definite spore-fruits) consisting of telioasci and teliospores. (Species about 4200.)
 - Order Uredinales. The Rusts. Typically with sporidia, pycniospores, aeciospores, urediniospores and teliospores.
 - Order Ustilaginales. The Smuts. Typically with sporidia and teliospores.
- Class 17. BASIDIOSPOREAE. Basidium Fungi. Spore-fruits containing one or more basidia with basidiospores. (Species about 14,000.)
 - Order Hymenogastrales. The False Tubers. Spore-fruits large, tuberous, subterranean, fleshy, with internal hymenium.
 - Order Phallales. The Stink Horns. Spore-fruits large, fleshy, at first tuberous and subterranean, later stalked and emerging.
 - Order Sclerodermatales. The Hard Puff-balls. Spore-fruits small to large, roundish, eventually pulverulent.
 - Order Nidulariales. Bird-nest Fungi. Spore-fruits small, spherical or top-shaped, leathery, containing peridioles.
 - Order Lycoperdales. The Puffballs. Spore-fruits large, fleshy, at first subterranean, later emerging.
 - Order Hymenomycetales. Toadstools, etc. Spore-fruits large, umbrella-shaped, bracket-shaped or variously branched; hymenium eventually external.
 - Order Exobasidiales. Reduced and degraded plants related to the preceding families; basidia undivided.
 - Order Auriculariales. Ear Fungi. Reduced and degraded plants related to the preceding families; basidia divided transversely.
 - Order Tremellales. Jelly Fungi. Reduced and degraded plants related to the preceding families; basidia divided vertically.

FUNGI IMPERFECTI. The "Imperfect Fungi." Including 16,000 to 17,000 species with regard to which our knowledge is quite imperfect. They are generally re-regarded as conidial states of Ascosporeae. The classification here given is merely provisional.

Order Sphaeropsidales. The Spot Fungi. Conidia developed in pycnidia.

Order Melanconiales. The Black-dot Fungi. Conidia developed on a stroma.

Order Hyphomycetales. The Moulds. Conidia developed upon separate conidiophores which do not form a stroma.

Phylum VIII. BRYOPHYTA

The Mossworks

Chlorophyll-green, small, massive, sexual plants (gametophytes), producing a small, spore-bearing generation (sporophyte).

Class 18. HEPATICAE. Liverworts. Gametophytes mostly bilateral, often thalloid, creeping; sporophytes usually splitting and containing elaters. (Species about 4,000.)

Order Ricciales. The Riccias. Sporophyte globose, sessile, without columella or elaters.

Order Anthocerotales. Hornworts. Sporophyte elongated, with a columella and elaters, two-valved.

Order Marchantiales. Liverworts proper. Sporophyte rounded, usually short stalked, without columella, indehiscent, containing elaters.

Order Jungermanniales. Scale Mosses. Sporophyte stalked, four-valved; with elaters.

Class 19. MUSCI. Mosses. Gametophytes multilateral, usually erect; sporophytes mostly dehiscent by a circular lid, and without elaters. (Species about 12,600.)

Order Andreaeales. Black Mosses. Sporophyte short-stalked, opening by four to six longitudinal slits.

Order Sphagnales. Peat Mosses. Sporophyte short-stalked, opening by a circular lid.

Order Bryales. True Mosses. Sporophytes mostly long-stalked, generally opening by a circular lid, usually with a peristome.

Suborder Acrocarpi. Sporophytes terminal on the main axis of the gametophyte.

Suborder Pleurocarpi. Sporophytes terminal on short lateral axis of the gametophyte.

Phylum IX. PTERIDOPHYTA

The Ferns

Chlorophyll-green, small, sexual plants (gametophytes), producing a large-leaved, rooted generation (sporophyte). (Here restricted to the ferns alone, and including about 2500 species.)

Class 20. EUSPORANGIATAE. Old-fashioned Ferns. Sporangia developed from internal cells.

Order Ophioglossales. Gametophyte tuberous, subterranean; sporophyte with large leaves, some parts sporogenous.

Order Marattiales. Gametophyte flat, green, superficial; sporophyte with large compound leaves; sporangia hypophyllous.

Order Isoetales. Gametophytes dioecious, rounded; sporophyte with erect, crowded, narrow leaves; sporangia epiphyllous, basal.

Class 21. LEPTOSPORANGIATAE. Modern Ferns. Sporangia developed from superficial cells.

Order Filicales. Land Ferns. Spores of one kind; gametophytes foliose, monoecious.

Order Hydropteridales. Water Ferns. Spores of two kinds; gametophytes dioecious, rounded.

Phylum X. CALAMOPHYTA

The Calamites

Minute sexual plants (gametophytes), producing cylindrical, jointed and rooted sporophytes. (Species living about 20, but very many extinct.)

Class 22. SPHENOPHYLLINEAE. The Wedge-leaved Calamites. Palaeozoic trees with solid, jointed stems, long extinct.

Order Sphenophyllales. With the characters of the class.

Class 23. Equisetineae. The Horsetails. Palaeozoic to recent plants with hollow, jointed stems.

Order Equisetales. With the characters of the class.

Class 24. CALAMARINEAE. Old Calamites. Palaeozoic plants, often trees, with hollow stems, long extinct.

Order Calamariales. With the characters of the class.

Phylum XI. LEPIDOPHYTA

The Lycopods

Minute gametophytes, producing branching, small-leaved, rooted sporophytes. (Species living about 900, but very many extinct.)

Class 25. ELIGULATE. Lower Lycopods. Isosporous; leaves without ligules.

Order Lycopodiales. Gametophyte much larger than the spore.

Class 26. LIGULATAE. Higher Lycopods. Heterosporous; leaves with ligules.

Order Selaginellales. Small plants; stems not thickening.

Order Lepidodendrales. Palaeozoic and Mesozoic trees, long extinct.

Phylum XII. CYCADOPHYTA

The Cycads

Minute gametophytes developed in naked seeds produced by the large, leafy-stemmed and rooted sporophytes; sperms motile. (Species living about 140, but very many extinct.)

Class 27. PTERIDOSPERMEAE. The Seed Ferns. Palaeozoic, fern-like plants, long extinct.

Order Pteridospermales. With the characters of the class.

Class 28. CYCADINEAE. The Common Cycads. Mesozoic to present plants with pinnate leaves.

Order Cycadales. With the characters of the class.

Class 29. BENNETTITINEAE. The Flowering-Plant Ancestors. Mesozoic plants with pinnate leaves, long extinct.

Order Bennettitales. With the characters of the class.

Class 30. CORDAITINEAE. The Conifer Ancestors. Palaeozoic to present, trees and shrubs with typically parallel-veined leaves, mostly long extinct.

- Order Cordaitales. Branching trees with elongated, parallel-veined leaves. (Extinct.)
- Order Ginkgoales. The Maidenhair Trees. Branching trees with fan-shaped, parallel-veined leaves. (All extinct but one species.)
- Order Gnetales. The Joint-Firs. Anomalous woody plants of doubtful relationship.

Phylum XIII. STROBILOPHYTA

The Conifers

Minute gametophytes developed in naked seeds produced by the large, leafy-stemmed and rooted sporophytes; sperms not motile. (Species about 450.)

- Class 31. PINOIDEAE. Mostly trees with increasing stems and small mostly persistent leaves; sporophylls mostly in cones.
- Order Coniferales. Conifers proper. Microsporophylls and megasporophylls in cones.
- Order Taxales. The Yews. Microsporophylls in cones, megasporophylls in very small cones or solitary.

Phylum XIV. ANTHOPHYTA

The Flowering Plants

Minute gametophytes developed in seeds enclosed in pistils in flowers, produced by the large, leafy-stemmed and rooted sporophytes; sperms not motile.

- Class 32. MONOCOTYLEDONEAE. The Monocotyledons. Leaves of sporophyte alternate from the first, usually parallel veined; fibrovascular bundles of stem scattered. (Species somewhat more than 20,000.)
- Subclass MONOCOTYLEDONEAE-HYPOGYNAE. Perianth and stamens arising below the carpels: (carpels superior).
- Order Alistamatales. Carpels separate, superior to all other parts of the flower.
- Order Liliales. Carpels (usually 3) united forming a compound pistil, superior; perianth in two whorls (of 3 each), corolla-like.
- Order Arales. Compound pistil mostly tricarpeal, superior; ovules solitary.

- Order Palmales. Compound pistil mostly tricarpellary, superior; ovules usually 1; perianth reduced to rigid scales.
- Order Graminales. Compound pistil reduced to 2 or 3 carpels; ovule solitary; perianth reduced to small scales, or wanting.
- Subclass MONOCOTYLEDONEAE-EPIGYNAE. Perianth and stamens arising above the carpels: (carpels inferior).
- Order Hydrales. Aquatics with an inferior ovary.
- Order Iridales. Compound tricarpellary pistil inferior; whorls of perianth mostly alike and regular.
- Order Orchidales. Compound tricarpellary pistil inferior; perianth irregular.
- Class 33. DICOTYLEDONEAE. The Dicotyledons. Leaves of young sporophyte opposite, sometimes continuing so, usually reticulate veined; fibrovascular bundles of stem in one or more rings. (Species about 90,000.)
- Subclass DICOTYLEDONEAE-THALAMIFLORAE. Axis of the flower (thalamus) normally cylindrical, hemispherical or flattened, bearing on its surface the hypogynous perianth, stamens and pistils (or the stamens may be attached to the corolla).
- Super-Order Thalamiflorae-Apopetalae-Polycarpellatae. Carpels typically many, separate or united; petals separate.
- Super-Order Thalamiflorae - Gamopetalae - Polycarpellatae. Carpels typically many, united; petals united.
- Super-Order Thalamiflorae-Apopetalae-Polycarpellatae. Carpels typically two, united; petals united.
- Subclass DICOTYLEDONEAE-CALYCIFLORAE. Axis of the flower normally expanded into a disk or cup, bearing on its margin the perianth and stamens, (or the latter may be attached to the corolla).
- Super-Order Calyciflorae-Apopetalae. Petals separate. Carpels many to few, separate to united, superior to inferior.
- Super-Order Calyciflorae-Gamopetalae. Petals united. Carpels few, united, inferior.